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THE ATMOSPHERIC SCIENCES LABORATORY PHOTODISSOCIATION-RADIATION--ETC(U)
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RESEARCH AND DEVELOPMENT TECHNICAL REPORT
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THE ATMOSPHERIC SCIENCES LABORATORY PHOTODISSOCIATION-RADIATION MODEL OF THE MIDDLE ATMOSPHERE

A USERS MANUAL

By

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July 1977

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1. REPORT NUMBER: ECOM-77-4	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): THE ATMOSPHERIC SCIENCES LABORATORY PHOTODISSOCIATION-RADIATION MODEL OF THE MIDDLE ATMOSPHERE - A USERS MANUAL	5. TYPE OF REPORT & PERIOD COVERED: SPECIAL REPORT. no. 11, #11
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Jerry L. Collins	8. CONTRACT OR GRANT NUMBER(s): DAAD07-74-C-0263
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Electrical Engineering Department, University of Texas at El Paso, El Paso, Texas 79968	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: United States Army Electronics Command, Atmospheric Sciences Laboratory, White Sands Missile Range, New Mexico 88002	12. REPORT DATE: July 1977
	13. NUMBER OF PAGES: 47
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): United States Army Electronics Command, Atmospheric Sciences Laboratory, White Sands Missile Range, New Mexico 88002	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A computer code to calculate time- and altitude-dependent photodissociation rates and transmitted solar flux intensities in the upper atmosphere has been developed for Atmospheric Sciences Laboratory, and is operational on the UNIVAC 1108 computer system at White Sands Missile Range. This document is presented to demonstrate to the interested user how to set up and execute the program. Included is a brief discussion of the files of absorption coefficients stored in FASTRAND direct access files and the various solar flux

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tape files which are stored in the UNIVAC 1108 System B Library.

Sixteen internally documented auxiliary programs available for plotting, file management, etc., are briefly described in Appendix A.

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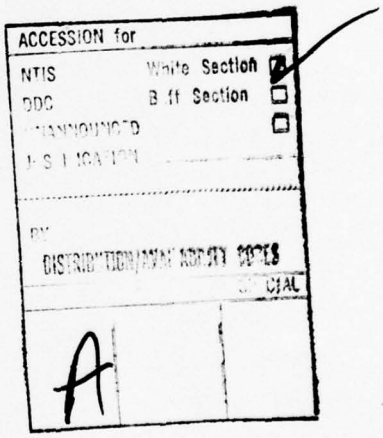

1. INTRODUCTION

The JVALUE program was developed to calculate photodissociation rates as a function of time, geographical location and altitude and is part of ANMAR, the ASL Numerical Model of Atmospheric Radiation, Composition and Dynamics. The photodissociation rates are used as input data for ASA, the chemical kinetic modeling program, also part of ANMAR. Altitude and time dependent solar flux intensities are predicted also. The computational technique has been reported previously.[1,2]

The software package is comprised of a single FORTRAN program to compute instantaneous rates. Because of the way in which ASA utilizes the photodissociation rates, only the noon, or maximum values need be calculated. If mean rates, averaged over several solar zenith angles are desired, a second FORTRAN program, MEAN, is available for the averaging. MEAN, and several other internally documented auxiliary programs, are listed and their respective functions briefly described in Appendix A.

Logical parameters within the program allow the selection of card, tape or FASTRAND output for the photodissociation rates. Solar flux intensities are stored on magnetic tape.

Card input to the program includes program control parameters, latitude and time for the calculation of solar zenith angles, wavelength intervals, quantum efficiencies, identification of the specific photodissociation processes considered, and density profiles for the set of absorbers. Experimental profiles are used when available, and other densities are predicted by ASA. In addition to the card input, a direct access file containing the absorption coefficients and the solar flux data must be supplied. All input data is described in more detail in the following sections.

2. PROGRAM INPUT

A. CARD INPUT

Card Type 1

COL.	NAME	FORMAT	DESCRIPTION
2-5	$NLV	Unformated	Defines namelist to follow.
6-n	JAYS		If JAYS = ·FALSE·, the subroutine to sum the individual photodissociation rates will not be called.
	PCH		If PCH = ·TRUE·, rates will be punched on cards in ASA format.
	ITAPE		If ITAPE = ·TRUE·, rates will be written on Unit 9 (tape or FASTRAND) in ASA format for storage, plotting, etc.
	IPHI		If IPHI = ·TRUE·, NSPEC factors will be read in to modify SIGMA, the total absorption coefficient, and SSIGMA, the photodissociation coefficient, or to modify the density profiles.
	DEN		If DEN = ·TRUE·, the input density profiles will be written out for each absorber.
	DATA		If DATA = ·TRUE·, input solar flux and absorption data will be written out. This should be invoked only for debugging or the examination of a small absorbing interval because more than 600,000 values, many of them zero, could be written out.
	SSUMIT		If SSUMIT = ·TRUE·, program will sum photoabsorption rates (from output FASTRAND file 8) only. This option prevents loss of the calculated values in case of machine error. It may also be used to examine the contribution from various absorbing intervals for a given specie.

Card Type 1 (contd.)

COL.	NAME	FORMAT	DESCRIPTION
	NFIL		The size of the input direct access file of absorption coefficients must be supplied. This value must be at least as large as IVAL2, the final wavelength.
last5 Columns	▽$END		Terminates namelist.

Note: All logical parameters are set to false in the program with the exception of JAYS, which is true. The namelist card is used to invoke the other options when desired and to furnish NFIL.

Card Type 2

1-5	MON	I5	Month of year,
6-10	MDAY	I5	day of month,
11-15	NHOUR	I5	time in hours
16-20	MIN	I5	and minutes (MST), for which photodissociation rates are to be calculated.
21-25	INC	I5	Time increment in minutes if more than one zenith angle is to be calculated.

Card Type 3

1-15	(LA(I), I=1,3)	3I5	Latitude in degrees, minutes and seconds.
1-15	(LN(I) I=1,3)	3I5	Longitude in degrees, minutes and seconds.

Card Type 4

1-72	(TITLE(I), I=1,12)	12A6	Alphanumeric identification of the run.

Card Type 5

COL.	NAME	FORMAT	DESCRIPTION
1-5	IVAL1	I5	First
6-10	IVAL2	I5	and last wavelength to be considered in the calculation
11-15	MSPEC	I5	The number of attenuating species. If all of the chemical absorbers are to be used to calculate the amount of solar flux transmitted, MSPEC = NSPEC, the number for which photodissociation rates are to be calculated.
16-20	NPOS1	I5	Number of solar flux values to skip so that the input tape will be positioned at IVAL1.
21-25	NPOS2*	I5	Key to control printed output. = 0 writes out only final ouput -- the rates as a function of altitude plus the card, FASTRAND, and/or tape output as specified. = 1 writes out all computed flux values. < 0 writes out all individual contributions to the photodissociation rates. > 1 writes out all of the above.
26-30	ISKIP	I5	Number of layers for which photodissociation rates will not be calculated.

*Note: This is primarily for debugging since writing out all data in a normal sized run would take many hundreds of pages. To examine the calculated solar flux values, the SOLPLT or the RADPLT program would be preferable. Examination of the per-interval contribution to photodissociation rates is better handled through input data to subroutine SUMIT and the logical option SSUMIT.

Card Type 6

1-5	NSPEC	I5	Total number of species which photodissociate.
6-10	NTHETA	I5	Up to twelve solar zenith angles may be computed but due to the very large

Card Type 6 (cont'd.)

COL.	NAME	FORMAT	DESCRIPTION
			output file 8 required (about 400 tracks/zenith angle), only one angle at a time is recommended.
11-15	NTOP	I5	Highest altitude to calculate (km).
16-20	NLAYER	I5	Number of altitudes to calculate (including NTOP).
21-25	NWAVE	I5	NWAVE = 100, the maximum number of wavelengths per cycle, where NCYCLE= (IVAL2-IVAL1)/100. Due to storage requirements, the computation is divided into NCYCLE intervals.
26-35	DZ	E15.5	The depth of each model layer in cm, currently set to 5×10^5 cm (5km).

Card Type 7

1-42	(LAYER(I), I=1,14)	14I3	NLAYER altitudes to calculate.

Card Type 8

1-10	SYMB	A6,4x	Chemical symbol for absorber (right-justified).
11-40	(N(K,J), J=1,6)	6I5	Wavelengths which define the thresholds for up to five photodissociation processes for the Kth specie (of NSPEC species). N(K,1) will always be set to IVAL1, the initial wavelength For example, the 4th absorber in one set of coefficients is NO_2. N(4,2) - N(4,1) defines the wavelength interval for the reaction $NO_2 + h\nu \rightarrow NO + O(^1D)$ and (N(4,3) - N(4,2) + 1) defines $NO_2 + h\nu \rightarrow NO + O$.

Note: There are NSPEC cards of type 8.

Card Type 9

COL.	NAME	FORMAT	DESCRIPTION
1-5	NEQ	I5	Total number of photodissociation reaction rates to be calculated.

Card Type 10

1-5	NS(I)	I5	Ith photodissociation process for a specie. (See note on Card Type 7.)
6-10	NE(I)	I5	NE(I) is the number of the chemical reaction in ASA which corresponds to the NS(Ith) photodissociation rate.
11-15	NR(I)	I5	The number of the specie in the set of chemical absorbers (contained in the direct access file).
16-20	FACTOR(I)	F5.3	Quantum efficiency.
20-66	(EON(I,J), J=1,6)	6A6	The alphanumeric representation of the chemical reaction and absorbing interval for identification purposes.

Note: There are NSPEC cards of type 10. To clarify this type card, an example is given:

3 1 11.000 O_2 + hν → O + O 1759-2500 Å

Field 1 specifies that this is the third photodissociation process for molecular oxygen, field 2 shows that it is reaction 1 in the current chemical kinetic scheme, and field 3 shows that oxygen is the first absorber in the set of absorption data. Field 4 shows a quantum yield of 1.000, and the balance of the card identifies the photodissociation reaction.

Card Type 11

1-12	EN(J,L)	E12.6	The average number density of the Jth specie at the center of the Lth layer.
13-24	SYMB(J)	6x,A6	The chemical symbol of the Jth specie.
25-34	LAYER(L)	6x,I3	The altitude of the Lth interval.

Card Type 11 (contd.)

COL	NAME	FORMAT	DESCRIPTION

Note: There are NLAYER cards for each of the NSPEC chemical species. The first card for each specie is the column density above the model.

Card Type 12

1-5	PHII (I)	F5.2	If IPHI = .TRUE., constant factors may be read in to adjust the entire set of total and photodissociation coefficients for each chemical absorber in the set. These constant factors also may be used to adjust the density profiles for given absorbers.
6-10	PHI (I)	F5.2	
.			
.			
.			
.			

Note: PHII and PHI values for each of the NSPEC absorbers are contained on consecutive cards, eight sets to each card.

Since there is so much card input, most or all of this data is usually stored in an ELT element within the program file. This data may then be referenced with the ADD Furpur. A sample of input data is given in Section 6.

B. INPUT DATA FILES

(1) An input tape of solar flux values must be supplied to the program. The following sets are available in the UNIVAC 1108 Computer B Tape Library:

File 1	Brinkman-Thakaekara[3,4] composite data	26-7500 Å
File 2	Ackerman[5]	1176-7275 Å
File 3	File 1 with Broadfood[6] data used in the 2000-3100 Å interval	26-7500 Å

These solar flux values have been averaged in units of photons-cm^{-2} $sec^{-1}Å^{-1}$ in 5(F10.2,E15.5) format.

(2) The direct access file of absorption coefficients, referenced internally as KFILE, contains data averaged over 1 Å intervals for up to 18 absorbers. The file-handling subroutines, LOADUA and DACESS, deliver NCYCLE sets of NWAVE

(100) total and dissociation absorption coefficients for each of the NSPEC species. The following relationships exist between the absorption coefficients and the cross-sections:

$$k_{i_T}(\lambda) = n_o \sigma_{i_T}(\lambda),$$

$$k_{i_D}(\lambda) = n_o \sigma_{i_D}(\lambda),$$

and

$$\sigma_{i_D}(\lambda) = \phi_i(\lambda)\ \sigma_{i_T}(\lambda).$$

where

$\sigma_{i_T}(\lambda)$ = Total absorption cross-section for the ith specie (cm^2).

$k_{i_T}(\lambda)$ = Total absorption coefficient for the ith specie (cm^{-1}).

$k_{i_D}(\lambda)$ = Dissociation coefficient for the ith specie (cm^{-1}).

n_o = Loschmidt's number ($n\text{-}cm^{-3}$).

$\phi_i(\lambda)$ = Quantum yield for a given photodissociation process of the ith specie.

$\sigma_{i_D}(\lambda)$ = The dissociation cross-section of the ith specie.

Very seldom are variable quantum yields known; therefore, $\sigma_{i_T}(\lambda)$ and $\sigma_{i_D}(\lambda)$ are set equal for most species. Constant quantum yields are best applied in subroutine SUMIT.

At present, data for fourteen absorbers are contained in one 270 track direct access file, COLLINS*COEFF. A second file, COLLINS*COEFF1., contains alternate data for several species. Additional data for eleven species not considered in ASA are stored in COLLINS*COEFF2. Initially, an extensive literature search[1] was made for absorption data and all data were generated over 1 A averages using an interpolation program (COLLINS*JONE3). Generated and original data sets were plotted to ascertain if corrections were required to maintain the integrity of the

maxima and minima. Usually sets of two- and four-point interpolations of the data were blended with original data to give a "best set." Where two or more sets of data were combined, it was often necessary to smooth data at the position of overlap. Backup tapes of these "best sets" are stored in the UNIVAC 1108 Computer B Tape Library with alternate sets stored for some species - primarily molecular oxygen, ozone, nitrogen dioxide and nitrous oxide.

These data also are stored in a (36 x N) array in the FASTRAND direct access file, with N set by the number of tracks chosen when the file is created. The program delivers (NSPEC x 100) values of the total and photodissociation coefficients from the direct access file to the main subroutine for (IVAL2-IVAL1) cycles for each layer calculated. Identifying wavelengths are also provided. (This file is more completely described in the internal documentation of Program DA.) All of the various data stored on mass storage in the UNIVAC 1108 system and Tape Library have been tabulated and identified in a notebook which is under the control of Harold Ballard, Contract Monitor.

3. EXECUTION SET-UP (EXEC-8 CONTROL CARDS)

Program execution requires the following sequence of control cards:

@QUAL	COLLINS	
@ASG,T	1.,T, (tape id)	The tape id is the UNIVAC Computer B Library number. This tape will be released after the first layer unless multiple zenith angles are computed.
@MSG,W BK101U PAN 8150 (user id)		The W option on the MSG card signals the computer operator to label the BK library tape with the label the user desires as identification.
@ASG,T	3.,T,BK101U	Output tape for solar flux data.
@ASG,T	7.,F,SCRTCH	Temporary storage for intermediate solar flux values.
@DELETE,C @ASG,UP @USE 8.,*JAY.	*JAY. *JAY.,F2/0/TRK/400	File to store individual contributions to the photodissociation rates.
@DELETE,C @ASG,UP @USE 9.,*12SEP.	*12SEP. *12SEP.,F	File to store photodissociation rates. Required if ITAPE=.TRUE.
@ENABLE,C @ASG,A @USE KFILE.,*COEFF.	*COEFF. *COEFF.	This assigns the direct access file containing the absorption coefficients.
@ENABLE,C @ASG,A @XQT Input cards types 1-11 @FIN	*JVALUE. *JVALUE. *JVALUE.	

Note: File 8 may be assigned as a temporary file; however, if there is difficulty with the machine when the program is near completion, all data will be lost. This file should be deleted after the successful termination of a job unless the user plans to use the SSUMIT option to look at contributions over various intervals. The @ENABLE,C and @DELETE,C cards are added to allow one to use the rerun option in case the job is lost due to machine error.

When a data set for a given set of absorbers at a given latitude has been assembled, one may use the ELT processer to diminish the card input for each run.

```
@ELT,IS              *JVALUE.CDATA
   Input cards types 5-11
```

Then to execute:

```
@XQT                 *JVALUE.
   Input data cards 1-4

@ADD,PE              *JVALUE.CDATA
```

A sample of the program output may be found in Section 7.

4. LOGICAL FLOW

Subroutine MAIN initially reads the logical parameters which specify the amounts and types of input/output data and the required input/output tape and FASTRAND files. The other card input data then is read into storage.

Subroutine ZEN, called by MAIN, calculates the specified number of solar zenith angles for the time of year and latitude. At this time, subroutines LOADUA and DACESS check the size and open the direct access file. A second call to these subroutines specifies the wavelengths to be delivered for each program cycle. (Due to the large amounts of solar flux and absorption data required, only 100 wavelengths are calculated in each cycle.)

The attenuation of the solar flux and the per-Angstrom contributions to the instantaneous photodissociation rates are calculated for each 100 wavelengths. The former values are stored on a temporary magnetic tape file until all wavelengths have been processed, at which time all solar flux values calculated for that altitude interval are dumped on a UNIVAC 1108 Library Tape file. This file is then repositioned and these data become input data for the next altitude interval. The per-Angstrom contributions to the rates are blocked into a FASTRAND file.

When all altitudes have been processed, subroutine SUMIT is called to sum the per-Angstrom contributions over the appropriate intervals for each photodissociation reaction considered for the set of absorbers. The quantum yield, if known, is usually applied here. The rates will be punched on cards and/or written on a FASTRAND or tape file.

5. MATHEMATICAL CALCULATIONS

The basic equation used for the calculation of photodissociation rates in the upper atmosphere is:

$$J_j(z,t) = \int_{\lambda_1}^{\lambda_2} \phi_i(\lambda)\, \sigma_{T_i}(\lambda)\, I_{T_\lambda}(z,t)\, d\lambda \qquad (1)$$

where:

$J_j(z,t)$ = Rate of the jth photodissociation process of the ith specie in the wavelength interval λ_1 to λ_2 (sec^{-1} $molecule^{-1}$),

i = index for the ith chemical absorber.

z = altitude (cm),

t = time of day, month and year,

$\sigma_{T_i}(\lambda)$ = total microscopic cross section for photoabsorption by the ith specie (cm^2),

$\phi_i(\lambda)$ = quantum yield of the ith specie, defined as the ratio of the dissociation cross section, $\sigma_{D_i}(\lambda)$ to the total cross section, and

$I_{T_\lambda}(z,t)$ = total intensity of the radiation about the interval $d\lambda$ incident on the top of the layer centered at altitude z (photons cm^{-2} sec^{-1} 0.1 nm^{-1}).

The photodissociation rate for a given density profile is given by

$$R_j(z,t) = \int_{z_1}^{z_2} J_i(z,t)\, [n_i(z,t)]\, dz \qquad (2)$$

where

$R_j(z,t)$ = jth photodissociation rate (sec^{-1}) of the ith specie at altitude z and time t,

$[n_i(z,t)]dz$ = the total number of molecules of the ith specie in the altitude interval from z_1 to z_2.

The intensity of the direct radiation incident upon the top of the model is obtained from the Bouguer-Lambert law[7]:

$$I_{D_\lambda}(z,t) = I_\lambda(\infty) \exp\left\{-\int_{\infty}^{z} [\alpha(\lambda,z,t) + \beta(\lambda,z,t)] \sec\theta_z(t)dz\right\} \quad (3)$$

where

$I_\lambda(\infty)$ = monochromatic radiation about the interval $d\lambda$ outside the earth's atmosphere. Subsequent model layers use the last calculated value of the solar flux, and

$\alpha(\lambda,z,t)$ = $\sum_i \sigma_{T_i}(\lambda)[n_i(z,t)]$, the attenuation coefficient due to absorption, (cm^{-1}),

$\beta(\lambda,z,t)$ = $\frac{32\pi^3 (\mu - 1)^2}{3\sum_i [n_i(z,t)]\lambda^4}$, the attenuation coefficient due to Rayleigh scattering (cm^{-1}),[8,9,10]

μ = index of refraction of air,

λ = wavelength (cm), and

$\sec\theta_z(t)$ = solar zenith angle at time t for a given geographic location, calculated by the standard approximation[11].

The contribution due to scattering is based on the Leighton[9,10] approximation.

6. SAMPLE OF INPUT

Shown in this section is a complete set of the required cards needed to execute the computer code JVALUE.

```
$NL ITAPE=.TRUE.,NFIL=8500, DEN=.TRUE.,IPHI=.TRUE. $END
   9    28    12     0     0
  32
 106
 SEPT 32 NORTH COMPOSITE 9/28/76
 976 3975     4   950     0     0
  16     1    70     5   100       0.50 E 06
  75    70    65    60    55    50    45    40    35    30    25    20    15    10
   02       1026 1332 1759 2500
   03       1990 2340 2600 3100 3340 3600
   N2       1305
  N02       1900 2410 2440 3985
 HN02       3970
 N2O5       2050 3800
 H2O2       2000 3800
 HCHO       3600
 HNO3       1900 2100 3250 3700
  N2O       1680 2550 3340
  HO2       2450
   NO       1217 2300
  H2O       1430 1980
  CH4        800 1625
  CO2        900 1200 1475 1980
 HCHO       3600
  24
    1     1     3 1.00      O2   = O + O  1759-2424
    1     2     2 1.00      O2   = O + O1D  1332-1759
    1     3     1 1.00      O2   = O + O1S  1026-1332
    2     6     4 .001      O3   = O    + O21D  3100-3340
    2     7     3 1.00      O3   = O1D  + O21D  2600-3100
    2     8     1 0.01      O3   = O1S  + O21D   1990-2370
    2     9     2 0.05      O3   = O    + O21S    2340-2600
    4    11     3 1.00     NO2 + HV = O    + NO   2440-3985
    4    12     1 0.50     NO2 + HV = O1D  + NO   1900-2410
    4    12     2 0.20     NO2 + HV = O1D  + NO   2410-2440
   10    13     6 0.99     N2O + HV = O1D  + N2  1680-3340
   10    14     6 0.01     N2O + HV = N    + NO  1680-2550
    6    17     6 0.50     N2O5 + HV = O    + NO2 +NO2
   11    19     6 1.00     HO2 + HV = O    + OH
    7    20     6 1.00    H2O2 + HV = OH   + OH
   15    21     2 1.00     CO2 + HV = O    + CO
   15    22     1 1.00     CO2 + HV = O1D  + CO
   14    23     6 0.33     CH4 + HV = H    + CH3
   14    24     6 0.67     CH4 + HV = H2   + CH2
    8    25     6 1.00    HCHO + HV = H    + CHO
   16    26     6 1.00    HCHO + HV = H2   + CO
    5    31     6 1.00    HNO2 + HV = NO   + OH
    9    32     6 1.00    HNO3 + HV = NO2  + OH  1900-3250
    9    33     1 0.01    HNO3 + HV = H + NO3  1190-2100
  .11700+21              02  OVER 75 KM.
  .42300+15              02       70 KM.
  .81900+15              02       65 KM.
  .15000+16              02       60 KM.
  .26200+16              02       55 KM.
 .447300+16              02       50 KM.
 .855000+16              02       45 KM.
```

.174000+17	O2		40 KM.
.371000+17	O2		35 KM.
.802000+17	O2		30 KM.
.174600+18	O2		25 KM.
.387400+18	O2		20 KM.
.848700+18	O2		15 KM.
.180000+19	O2		10 KM.
.10000+14	O3	OVER	75 KM.
1.00000+10	O3		70 KM.
.19100+11	O3		65 KM.
.31900+11	O3		60 KM.
.70400+11	O3		55 KM.
.800000+11	O3		50 KM.
.250000+12	O3		45 KM.
.700000+12	O3		40 KM.
.151840+13	O3		35 KM.
.352700+13	O3		30 KM.
.500600+13	O3		25 KM.
.399910+13	O3		20 KM.
.224980+13	O3		15 KM.
.100120+13	O3		10 KM.
.43800+21	N2	OVER	75 KM.
.15800+16	N2		70 KM.
.30500+16	N2		65 KM.
.56000+16	N2		60 KM.
.97800+16	N2		55 KM.
.166700+17	N2		50 KM.
.319200+17	N2		45 KM.
.648800+17	N2		40 KM.
.137400+18	N2		35 KM.
.299000+18	N2		30 KM.
.650700+18	N2		25 KM.
.144400+19	N2		20 KM.
.316300+19	N2		15 KM.
.671300+19	N2		10 KM.
.0	NO2	OVER	75 KM.
.10000+06	NO2		70 KM.
.60000+06	NO2		65 KM.
.20500+07	NO2		60 KM.
.11000+08	NO2		55 KM.
.200000+06	NO2		50 KM.
.400000+08	NO2		45 KM.
.400000+09	NO2		40 KM.
.169710+10	NO2		35 KM.
.253100+10	NO2		30 KM.
.261050+10	NO2		25 KM.
.184100+10	NO2		20 KM.
.164560+10	NO2		15 KM.
.172280+10	NO2		10 KM.
.0	HNO2	OVER	75 KM.
.10000E-02	HNO2		70 KM.
.13000E-01	HNO2		65 KM.
.31000E-01	HNO2		60 KM.
.50000E-01	HNO2		55 KM.
.566140+06	HNO2		50 KM.
.300960+07	HNO2		45 KM.

.111160+08	HNO2		40 KM.
.162140+08	HNO2		35 KM.
.137620+08	HNO2		30 KM.
.103470+08	HNO2		25 KM.
.994620+07	HNO2		20 KM.
.140690+08	HNO2		15 KM.
.164820+08	HNO2		10 KM.
.0	N2O5	OVER	75 KM.
.18598-01	N2O5		70 KM.
.90000-01	N2O5		65 KM.
.17685+03	N2O5		60 KM.
.10000+04	N2O5		55 KM.
.907050+01	N2O5		50 KM.
.592310+04	N2O5		45 KM.
.175550+07	N2O5		40 KM.
.482650+08	N2O5		35 KM.
.228780+09	N2O5		30 KM.
.429510+09	N2O5		25 KM.
.325840+09	N2O5		20 KM.
.265800+09	N2O5		15 KM.
.268930+09	N2O5		10 KM.
.0	H2O2	OVER	75 KM.
.20000+05	H2O2		70 KM.
.60000+05	H2O2		65 KM.
.90000+05	H2O2		60 KM.
.20000+06	H2O2		55 KM.
.601700+07	H2O2		50 KM.
.112840+08	H2O2		45 KM.
.179810+08	H2O2		40 KM.
.241310+08	H2O2		35 KM.
.417810+08	H2O2		30 KM.
.421880+08	H2O2		25 KM.
.328470+08	H2O2		20 KM.
.297320+08	H2O2		15 KM.
.361450+08	H2O2		10 KM.
.0	HCHO	OVER	75 KM.
.10000+06	HCHO		70 KM.
.40000+06	HCHO		65 KM.
6.20000+05	HCHO		60 KM.
1.30000+05	HCHO		55 KM.
7.00000+06	HCHO		50 KM.
1.20000+07	HCHO		45 KM.
2.05000+07	HCHO		40 KM.
1.90000+07	HCHO		35 KM.
1.20000+07	HCHO		30 KM.
9.00000+06	HCHO		25 KM.
2.90000+07	HCHO		20 KM.
5.30000+07	HCHO		15 KM.
7.70000+07	HCHO		10 KM.
.0	HNO3	OVER	75 KM.
1.00000+03	HNO3		70 KM.
6.00000+03	HNO3		65 KM.
1.50000+04	HNO3		60 KM.
1.00000+05	HNO3		55 KM.
.700000+05	HNO3		50 KM.
.204670+07	HNO3		45 KM.

.550000+08	HNO3		40 KM.
.150000+09	HNO3		35 KM.
.880450+09	HNO3		30 KM.
.466300+10	HNO3		25 KM.
.999410+10	HNO3		20 KM.
.710190+10	HNO3		15 KM.
.118550+10	HNO3		10 KM.
0.0	N2O	OVER	75 KM.
1.00000+04	N2O		70 KM.
7.00000+04	N2O		65 KM.
3.20000+05	N2O		60 KM.
4.00000+06	N2O		55 KM.
.100000+04	N2O		50 KM.
.300000+06	N2O		45 KM.
.130000+09	N2O		40 KM.
.478090+10	N2O		35 KM.
.407080+11	N2O		30 KM.
.202340+12	N2O		25 KM.
.598730+12	N2O		20 KM.
.124980+13	N2O		15 KM.
.239980+13	N2O		10 KM.
.0	HO2	OVER	75 KM.
.18000+05	HO2		70 KM.
.38000+05	HO2		65 KM.
.53000+06	HO2		60 KM.
.13000+07	HO2		55 KM.
.116420+08	HO2		50 KM.
.168000+08	HO2		45 KM.
.252060+08	HO2		40 KM.
.507040+08	HO2		35 KM.
.896060+08	HO2		30 KM.
.102280+09	HO2		25 KM.
.727910+08	HO2		20 KM.
.538650+08	HO2		15 KM.
.486180+08	HO2		10 KM.
.0	NO	OVER	75 KM.
.25000+08	NO		70 KM.
.83000+08	NO		65 KM.
.27000+09	NO		60 KM.
.76000+09	NO		55 KM.
.845760+09	NO		50 KM.
.161370+10	NO		45 KM.
.256370+10	NO		40 KM.
.263490+10	NO		35 KM.
.229750+10	NO		30 KM.
.189270+10	NO		25 KM.
.179760+10	NO		20 KM.
.266550+10	NO		15 KM.
.438570+10	NO		10 KM.
.0	H2O	OVER	75 KM.
.50887+10	H2O		70 KM.
.10000+11	H2O		65 KM.
.16531+11	H2O		60 KM.
.40000+11	H2O		55 KM.
.116630+12	H2O		50 KM.
.194340+12	H2O		45 KM.

```
.343950+12          H2O          40 KM.
.676180+12          H2O          35 KM.
.144950+13          H2O          30 KM.
.307780+13          H2O          25 KM.
.731920+13          H2O          20 KM.
.202050+14          H2O          15 KM.
.103000+15          H2O          10 KM.
  .0                CH4 OVER     75 KM.
 .15000+09          CH4          70 KM.
 .40009+09          CH4          65 KM.
 .09429+10          CH4          60 KM.
 .23002+10          CH4          55 KM.
.596450+10          CH4          50 KM.
.168180+11          CH4          45 KM.
.467340+11          CH4          40 KM.
.129700+12          CH4          35 KM.
.324050+12          CH4          30 KM.
.809400+12          CH4          25 KM.
.189870+13          CH4          20 KM.
.480030+13          CH4          15 KM.
.103920+14          CH4          10 KM.
  .0                CO2 OVER     75 KM.
 .52100+12          CO2          70 KM.
 .10000+13          CO2          65 KM.
 .20000+13          CO2          60 KM.
 .37009+13          CO2          55 KM.
.725870+13          CO2          50 KM.
.139010+14          CO2          45 KM.
.283020+14          CO2          40 KM.
.597930+14          CO2          35 KM.
.130000+15          CO2          30 KM.
.283000+15          CO2          25 KM.
.629000+15          CO2          20 KM.
.138000+16          CO2          15 KM.
.292000+16          CO2          10 KM.
  .0               HCHO OVER     75 KM.
 .10000+06         HCHO          70 KM.
 .40000+06         HCHO          65 KM.
6.20000+05         HCHO          60 KM.
1.30000+05         HCHO          55 KM.
7.00000+06         HCHO          50 KM.
1.20000+07         HCHO          45 KM.
2.05000+07         HCHO          40 KM.
1.90000+07         HCHO          35 KM.
1.20000+07         HCHO          30 KM.
9.00000+06         HCHO          25 KM.
2.90000+07         HCHO          20 KM.
5.30000+07         HCHO          15 KM.
7.70000+07         HCHO          10 KM.
1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1   0 1.00 1.00 1.00 1.00 1.00 1.00
```

7. SAMPLE OF OUTPUT

Shown here is a sample printer output listing generated with the input data listed in Section 6.

```
     LATITUDE          LONGITUDE
  DEG   MIN   SEC     DEG   MIN   SEC

  65     0     0      106     0     0

 LATITUDE  =    1.13447 RADIANS
 LONGITUDE =    1.85005 RADIANS

 MONTH DATE    TIME   INC

    9   28     12.00     0

 COSINE    =     .37693
 SECANT    =    2.65305
 THETA     =    1.18432 RADIANS OR     67.86164 DEGREES


$NL
 DEN       =   T
 PCH       =   F
 ITAPE     =   T
 IPHI      =   F
 JAYS      =   T
 DATA      =   F
 SSUMIT    =   F
 NFIL      =                +5000

$END

 THE NUMBER OF PHOTODISSOCIATION REACTIONS CONSIDERED IS 25
```

```
65 NORTH LATITUDE - SEPTEMBER 28 - 12 NOON

INTERVAL NCYCLE     NPOS1  NPOS2 ISKIP

976 3975   30        950      0     0

 NSPEC NTHETA  NTOP   NLAYER NWAVE  LAYER(CM)

  16      1    70 KM.    14     100   .500+06

CHEMICAL SYMBOLS

   O2     O3     N2    NO2   HNO2  N2O5  H2O2  HCHO  HNO3   N2O   HO2
   NO    H2O    CH4    CO2   HCHO

ISKIP = 0 IS THE NUMBER OF LAYERS FOR WHICH RATES WILL NOT BE COMPUTED

MSPEC = 4 IS THE NUMBER OF ATTENUATING SPECIES ABOVE MODEL

COLUMN DENSITIES ABOVE   70 KM.

.117000+21          O2 OVER  70
.100000+14          O3 OVER  70
.438000+21          N2 OVER  70
.000000            NO2 OVER  70


NUMBER DENSITIES SPECIE     ALTITUDE

.423000+15          O2        70 KM.
.819000+15          O2        65 KM.
.150000+16          O2        60 KM.
.262000+16          O2        55 KM.
.398000+16          O2        50 KM.
.838000+16          O2        45 KM.
.180000+17          O2        40 KM.
.377000+17          O2        35 KM.
.836000+17          O2        30 KM.
.177000+18          O2        25 KM.
.380000+18          O2        20 KM.
.810000+18          O2        15 KM.
.178000+19          O2        10 KM.


.100000+11          O3        70 KM.
.191000+11          O3        65 KM.
.319000+11          O3        60 KM.
.704000+11          O3        55 KM.
.221740+11          O3        50 KM.
.100170+12          O3        45 KM.
.475800+12          O3        40 KM.
.118340+13          O3        35 KM.
.213690+13          O3        30 KM.
.382660+13          O3        25 KM.
.526950+13          O3        20 KM.
.399940+13          O3        15 KM.
```

.212950+13	O3	10 KM.
.158000+16	N2	70 KM.
.305000+16	N2	65 KM.
.560000+16	N2	60 KM.
.978000+16	N2	55 KM.
.142000+17	N2	50 KM.
.312000+17	N2	45 KM.
.672000+17	N2	40 KM.
.141000+18	N2	35 KM.
.312000+18	N2	30 KM.
.661000+18	N2	25 KM.
.142000+19	N2	20 KM.
.302000+19	N2	15 KM.
.664000+19	N2	10 KM.
.100000+06	NO2	70 KM.
.600000+06	NO2	65 KM.
.205000+07	NO2	60 KM.
.110000+08	NO2	55 KM.
.130920+08	NO2	50 KM.
.722310+08	NO2	45 KM.
.388110+09	NO2	40 KM.
.114690+10	NO2	35 KM.
.256170+10	NO2	30 KM.
.363700+10	NO2	25 KM.
.350680+10	NO2	20 KM.
.155680+10	NO2	15 KM.
.203900+10	NO2	10 KM.
.100000-02	HNO2	70 KM.
.130000-01	HNO2	65 KM.
.310000-01	HNO2	60 KM.
.500000-01	HNO2	55 KM.
.438840+06	HNO2	50 KM.
.185250+07	HNO2	45 KM.
.531230+07	HNO2	40 KM.
.127130+08	HNO2	35 KM.
.689250+07	HNO2	30 KM.
.407420+07	HNO2	25 KM.
.308240+07	HNO2	20 KM.
.180320+07	HNO2	15 KM.
.176700+07	HNO2	10 KM.
.185980-01	N2O5	70 KM.
.900000-01	N2O5	65 KM.
.176850+03	N2O5	60 KM.
.100000+04	N2O5	55 KM.
.114380+02	N2O5	50 KM.
.180820+04	N2O5	45 KM.
.263270+06	N2O5	40 KM.
.516550+07	N2O5	35 KM.
.849140+08	N2O5	30 KM.

.387780+09	N2O5	25 KM.
.569940+09	N2O5	20 KM.
.344980+09	N2O5	15 KM.
.595550+09	N2O5	10 KM.
.200000+05	H2O2	70 KM.
.600000+05	H2O2	65 KM.
.900000+05	H2O2	60 KM.
.200000+06	H2O2	55 KM.
.183080+08	H2O2	50 KM.
.629110+08	H2O2	45 KM.
.128910+09	H2O2	40 KM.
.357970+09	H2O2	35 KM.
.136850+09	H2O2	30 KM.
.474320+08	H2O2	25 KM.
.223400+08	H2O2	20 KM.
.168130+08	H2O2	15 KM.
.952830+07	H2O2	10 KM.
.100000+06	HCHO	70 KM.
.400000+06	HCHO	65 KM.
.620000+06	HCHO	60 KM.
.130000+06	HCHO	55 KM.
.994760+06	HCHO	50 KM.
.389200+07	HCHO	45 KM.
.103990+08	HCHO	40 KM.
.145000+08	HCHO	35 KM.
.135840+08	HCHO	30 KM.
.116880+08	HCHO	25 KM.
.100540+08	HCHO	20 KM.
.118130+08	HCHO	15 KM.
.141180+08	HCHO	10 KM.
.100000+04	HNO3	70 KM.
.600000+04	HNO3	65 KM.
.150000+05	HNO3	60 KM.
.100000+06	HNO3	55 KM.
.988650+06	HNO3	50 KM.
.276050+07	HNO3	45 KM.
.338950+08	HNO3	40 KM.
.316850+09	HNO3	35 KM.
.264360+10	HNO3	30 KM.
.600150+10	HNO3	25 KM.
.130100+11	HNO3	20 KM.
.139930+11	HNO3	15 KM.
.302020+10	HNO3	10 KM.
.100000+05	N2O	70 KM.
.700000+05	N2O	65 KM.
.320000+06	N2O	60 KM.
.400000+07	N2O	55 KM.
.447640+05	N2O	50 KM.
.333020+06	N2O	45 KM.

.129980+09	N2O	40 KM.
.478100+10	N2O	35 KM.
.407080+11	N2O	30 KM.
.202340+12	N2O	25 KM.
.598730+12	N2O	20 KM.
.124980+13	N2O	15 KM.
.239980+13	N2O	10 KM.
.180000+05	HO2	70 KM.
.380000+05	HO2	65 KM.
.530000+06	HO2	60 KM.
.130000+07	HO2	55 KM.
.208300+08	HO2	50 KM.
.381010+08	HO2	45 KM.
.676660+08	HO2	40 KM.
.112910+09	HO2	35 KM.
.141820+09	HO2	30 KM.
.104200+09	HO2	25 KM.
.759600+08	HO2	20 KM.
.572130+08	HO2	15 KM.
.375550+08	HO2	10 KM.
.250000+08	NO	70 KM.
.830000+08	NO	65 KM.
.270000+09	NO	60 KM.
.760000+09	NO	55 KM.
.145610+10	NO	50 KM.
.166860+10	NO	45 KM.
.189690+10	NO	40 KM.
.326200+10	NO	35 KM.
.320000+10	NO	30 KM.
.282990+10	NO	25 KM.
.205720+10	NO	20 KM.
.109270+10	NO	15 KM.
.194880+10	NO	10 KM.
.508870+10	H2O	70 KM.
.100000+11	H2O	65 KM.
.165310+11	H2O	60 KM.
.400000+11	H2O	55 KM.
.762420+11	H2O	50 KM.
.221080+12	H2O	45 KM.
.413120+12	H2O	40 KM.
.576170+12	H2O	35 KM.
.124020+13	H2O	30 KM.
.288010+13	H2O	25 KM.
.705010+13	H2O	20 KM.
.147000+14	H2O	15 KM.
.255000+14	H2O	10 KM.
.150000+09	CH4	70 KM.
.400090+09	CH4	65 KM.
.942900+09	CH4	60 KM.

.230020+10	CH4	55 KM.
.474770+10	CH4	50 KM.
.124870+11	CH4	45 KM.
.349820+11	CH4	40 KM.
.100000+12	CH4	35 KM.
.279000+12	CH4	30 KM.
.750000+12	CH4	25 KM.
.150000+13	CH4	20 KM.
.348000+13	CH4	15 KM.
.750000+13	CH4	10 KM.

.521000+12	CO2	70 KM.
.100000+13	CO2	65 KM.
.200000+13	CO2	60 KM.
.370090+13	CO2	55 KM.
.597010+13	CO2	50 KM.
.126000+14	CO2	45 KM.
.270010+14	CO2	40 KM.
.565000+14	CO2	35 KM.
.125000+15	CO2	30 KM.
.266000+15	CO2	25 KM.
.569000+15	CO2	20 KM.
.121000+16	CO2	15 KM.
.267000+16	CO2	10 KM.

.100000+06	HCHO	70 KM.
.400000+06	HCHO	65 KM.
.620000+06	HCHO	60 KM.
.130000+06	HCHO	55 KM.
.994760+06	HCHO	50 KM.
.389200+07	HCHO	45 KM.
.103990+08	HCHO	40 KM.
.145000+08	HCHO	35 KM.
.135840+08	HCHO	30 KM.
.116880+08	HCHO	25 KM.
.100540+08	HCHO	20 KM.
.118130+08	HCHO	15 KM.
.141180+08	HCHO	10 KM.

SPECIE	PHII	PHI
O2	.100+01	.100+01
O3	.100+01	.100+01
N2	.100+01	.100+01
NO2	.100+01	.100+01
HNO2	.100+01	.100+01
N2O5	.100+01	.100+01
H2O2	.100+01	.100+01
HCHO	.100+01	.100+01
HNO3	.100+01	.100+01
N2O	.100+01	.100+01
HO2	.100+01	.100+01

NO	.100+01	.100+01
H2O	.100+01	.100+01
CH4	.100+01	.100+01
CO2	.100+01	.100+01
HCHO	.100+01	.100+01

MODEL LAYERS CENTERED AT FOLLOWING ALTITUDES

70	65	60	55	50	45	40	35	30	25	20	15	10

```
JJ =  1 DZ  =   .133+07
MODEL LAYER =  2     ALTITUDE =   70 KM.     DX =  .1327+07
MODEL LAYER =  3     ALTITUDE =   65 KM.     DX =  .1327+07
MODEL LAYER =  4     ALTITUDE =   60 KM.     DX =  .1327+07
MODEL LAYER =  5     ALTITUDE =   55 KM.     DX =  .1327+07
MODEL LAYER =  6     ALTITUDE =   50 KM.     DX =  .1327+07
MODEL LAYER =  7     ALTITUDE =   45 KM.     DX =  .1327+07
MODEL LAYER =  8     ALTITUDE =   40 KM.     DX =  .1327+07
MODEL LAYER =  9     ALTITUDE =   35 KM.     DX =  .1327+07
MODEL LAYER = 10     ALTITUDE =   30 KM.     DX =  .1327+07
MODEL LAYER = 11     ALTITUDE =   25 KM.     DX =  .1327+07
MODEL LAYER = 12     ALTITUDE =   20 KM.     DX =  .1327+07
MODEL LAYER = 13     ALTITUDE =   15 KM.     DX =  .1327+07
MODEL LAYER = 14     ALTITUDE =   10 KM.     DX =  .1327+07
```

SPECIE	EQN.	RATE	EFF.	CHEMICAL REACTION	
1	1	3	1.000	O2 = O + O	1759-2424
1	2	2	1.000	O2 = O + O1D	1332-1759
1	3	1	1.000	O2 = O + O1S	1026-1332
2	6	4	0.001	O3 = O + O2 1D	3100-3340
2	7	3	1.000	O3 = O1D + O2 1D	2600-3100
2	8	1	.010	O3 = O1S + O2 1D	1990-2370
2	9	2	.050	O3 = O + O2 1S	2340-2600
4	11	3	1.000	NO2 + HV = O + NO	2440-3985
4	12	1	.500	NO2 + HV = O1D + NO	1900-2410
4	12	2	.200	NO2 + HV = O1D + NO	2410-2440
10	13	6	.990	N2O + HV = O1D + N2	1680-3340
10	14	6	.010	N2O + HV = N + NO	1680-2550
6	17	6	.500	N2O5 + HV = O + NO2	+NO2
11	19	6	1.000	HO2 + HV = O + OH.	
7	20	6	1.000	H2O2 + HV = OH + OH	
15	21	2	1.000	CO2 + HV = O + CO	
15	22	1	1.000	CO2 + HV = O1D + CO	
14	23	6	.330	CH4 + HV = H + CH3	
14	24	6	.670	CH4 + HV = H2 + CH2	
8	25	6	1.000	HCHO + HV = H + CHO	
16	26	6	1.000	HCHO + HV = H2 + CO	
5	31	6	1.000	HNO2 + HV = NO + OH	
9	32	6	1.000	HNO3 + HV = NO2 + OH	1900-3250
9	33	1	.010	HNO3 + HV = H + NO3	11900-2100

THE FOLLOWING ARE THE WAVELENGTH INTERVALS
OVER WHICH TH PER ANGSTROM CONTRIBUTIONS
ARE SUMMED FOR DIFFERENT PHOTO-DISSOCIATION
POCESSES:

O2	976	1332	1759	2500	0	0
O3	976	2340	2600	3100	3340	3600
N2	976	977	0	0	0	0
NO2	976	2410	2440	3975	0	0
HNO2	976	977	0	0	0	0
N2O5	976	3800	0	0	0	0
H2O2	976	3800	0	0	0	0
HCHO	976	977	0	0	0	0
HNO3	976	2100	3250	3700	0	0
N2O	976	2550	3340	0	0	0
HO2	976	977	0	0	0	0
NO	976	2300	0	0	0	0
H2O	976	1980	0	0	0	0
CH4	976	1625	0	0	0	0
CO2	976	1200	1475	1980	0	0
HCHO	976	977	0	0	0	0

SYMB	SUM1	SUM2	SUM3	SUM4	SUM5	TOTAL
O_2	.0000	.3411-10	.0000	.7324-09	.0000	.7665-09
O_3	.1752-05	.1883-03	.8363-03	.1908-02	.2198-05	.2936-02
N_2	.0000	.0000	.0000	.0000	.0000	.0000
NO_2	.3142-05	.2920-04	.2924-02	.0000	.0000	.2956-02
HNO_2	.1980-03	.0000	.0000	.0000	.0000	.1980-03
N_2O_5	.1896-06	.1814-03	.0000	.0000	.0000	.1815-03
H_2O_2	.2543-05	.4881-04	.0000	.0000	.0000	.5135-04
HCHO	.8960-04	.0000	.0000	.0000	.0000	.8960-04
HNO_3	.4025-04	.1426-04	.1958-05	.0000	.0000	.5647-04
N_2O	.8719-08	.5400-06	.0000	.0000	.0000	.5487-06
HO_2	.2164-04	.0000	.0000	.0000	.0000	.2164-04
NO	.6231-08	.1360-05	.0000	.0000	.0000	.1367-05
H_2O	.1452-06	.0000	.0000	.0000	.0000	.1452-06
CH_4	.0000	.1409-07	.4228-07	.0000	.0000	.5638-07
CO_2	.0000	.1237-08	.0000	.0000	.0000	.1237-08
HCHO	.5981-04	.0000	.0000	.0000	.0000	.5981-04

ALTITUDE = 70 KM.

1	.73-09	70 KM.
2	.10-22	70 KM.
3	.34-10	70 KM.
6	.22-08	70 KM.
7	.19-02	70 KM.
8	.19-05	70 KM.
9	.42-04	70 KM.
11	.29-02	70 KM.
12	.15-04	70 KM.
13	.53-06	70 KM.
14	.54-08	70 KM.
15	.17-02	70 KM.
16	.27-02	70 KM.
17	.91-04	70 KM.
19	.22-04	70 KM.
20	.49-04	70 KM.
21	.12-08	70 KM.
22	.10-22	70 KM.
23	.14-07	70 KM.
24	.42-07	70 KM.
25	.90-04	70 KM.
26	.60-04	70 KM.
31	.20-03	70 KM.
32	.56-04	70 KM.
33	.56-06	70 KM.

SYMB	SUM1	SUM2	SUM3	SUM4	SUM5	TOTAL
O_2	.0000	.9150-13	.0000	.5085-09	.0000	.5086-09
O_3	.1272-05	.1611-03	.6811-03	.1624-02	.1966-05	.2469-02
N_2	.0000	.0000	.0000	.0000	.0000	.0000
NO_2	.1601-05	.2522-04	.2707-02	.0000	.0000	.2734-02
HNO_2	.1842-03	.0000	.0000	.0000	.0000	.1842-03
N_2O_5	.1875-06	.1581-03	.0000	.0000	.0000	.1583-03
H_2O_2	.2171-05	.4278-04	.0000	.0000	.0000	.4495-04
HCHO	.8304-04	.0000	.0000	.0000	.0000	.8304-04
HNO_3	.3455-04	.1219-04	.1776-05	.0000	.0000	.4852-04
N_2O	.2436-10	.4193-06	.0000	.0000	.0000	.4193-06
HO_2	.1878-04	.0000	.0000	.0000	.0000	.1878-04
NO	.1753-10	.1191-05	.0000	.0000	.0000	.1191-05
H_2O	.4367-07	.0000	.0000	.0000	.0000	.4367-07
CH_4	.0000	.3955-10	.1186-09	.0000	.0000	.1582-09
CO_2	.0000	.4949-09	.0000	.0000	.0000	.4949-09
HCHO	.5504-04	.0000	.0000	.0000	.0000	.5504-04

ALTITUDE = 65 KM.

1	.51-09	65 KM.
2	.10-22	65 KM.
3	.91-13	65 KM.
6	.20-08	65 KM.
7	.16-02	65 KM.
8	.16-05	65 KM.
9	.34-04	65 KM.
11	.27-02	65 KM.
12	.13-04	65 KM.
13	.42-06	65 KM.
14	.42-08	65 KM.
15	.17-02	65 KM.
16	.27-02	65 KM.
17	.79-04	65 KM.
19	.19-04	65 KM.
20	.43-04	65 KM.
21	.49-09	65 KM.
22	.10-22	65 KM.
23	.40-10	65 KM.
24	.12-09	65 KM.
25	.83-04	65 KM.
26	.55-04	65 KM.
31	.18-03	65 KM.
32	.49-04	65 KM.
33	.49-06	65 KM.

SYMB	SUM1	SUM2	SUM3	SUM4	SUM5	TOTAL
O_2	.0000	.6797-17	.0000	.4143-09	.0000	.4143-09
O_3	.1154-05	.1421-03	.5213-03	.1397-02	.1949-05	.2064-02
N_2	.0000	.0000	.0000	.0000	.0000	.0000
NO_2	.1182-05	.2302-04	.2693-02	.0000	.0000	.2717-02
HNO_2	.1836-03	.0000	.0000	.0000	.0000	.1836-03
N_2O_5	.1837-06	.1431-03	.0000	.0000	.0000	.1433-03
H_2O_2	.2043-05	.3906-04	.0000	.0000	.0000	.4110-04
HCHO	.8249-04	.0000	.0000	.0000	.0000	.8249-04
HNO_3	.3216-04	.1091-04	.1738-05	.0000	.0000	.4481-04
N_2O	.8581-14	.3802-06	.0000	.0000	.0000	.3802-06
HO_2	.1701-04	.0000	.0000	.0000	.0000	.1701-04
NO	.2612-14	.1111-05	.0000	.0000	.0000	.1111-05
H_2O	.2911-07	.0000	.0000	.0000	.0000	.2911-07
CH_4	.0000	.4906-14	.1472-13	.0000	.0000	.1962-13
CO_2	.0000	.3936-09	.0000	.0000	.0000	.3936-09
HCHO	.5437-04	.0000	.0000	.0000	.0000	.5437-04

ALTITUDE = 60 KM.

1	.41-09	60 KM.
2	.10-22	60 KM.
3	.68-17	60 KM.
6	.19-08	60 KM.
7	.14-02	60 KM.
8	.14-05	60 KM.
9	.26-04	60 KM.
11	.27-02	60 KM.
12	.12-04	60 KM.
13	.38-06	60 KM.
14	.38-08	60 KM.
15	.17-02	60 KM.
16	.27-02	60 KM.
17	.72-04	60 KM.
19	.17-04	60 KM.
20	.39-04	60 KM.
21	.39-09	60 KM.
22	.10-22	60 KM.
23	.49-14	60 KM.
24	.15-13	60 KM.
25	.82-04	60 KM.
26	.54-04	60 KM.
31	.18-03	60 KM.
32	.45-04	60 KM.
33	.45-06	60 KM.

SYMB	SUM1	SUM2	SUM3	SUM4	SUM5	TOTAL
O_2	.0000	.1657-21	.0000	.3138-09	.0000	.3138-09
O_3	.1023-05	.1174-03	.3365-03	.1111-02	.1931-05	.1568-02
N_2	.0000	.0000	.0000	.0000	.0000	.0000
NO_2	.8083-06	.2021-04	.2677-02	.0000	.0000	.2698-02
HNO_2	.1829-03	.0000	.0000	.0000	.0000	.1829-03
N_2O_5	.1771-06	.1245-03	.0000	.0000	.0000	.1246-03
H_2O_2	.1881-05	.3444-04	.0000	.0000	.0000	.3632-04
HCHO	.8187-04	.0000	.0000	.0000	.0000	.8187-04
HNO_3	.2928-04	.9307-05	.1685-05	.0000	.0000	.4027-04
N_2O	.2403-18	.3352-06	.0000	.0000	.0000	.3352-06
HO_2	.1477-04	.0000	.0000	.0000	.0000	.1477-04
NO	.6974-19	.1005-05	.0000	.0000	.0000	.1005-05
H_2O	.1757-07	.0000	.0000	.0000	.0000	.1757-07
CH_4	.0000	.1287-18	.3861-18	.0000	.0000	.5148-18
CO_2	.0000	.2949-09	.0000	.0000	.0000	.2949-09
HCHO	.5351-04	.0000	.0000	.0000	.0000	.5351-04

ALTITUDE = 55 KM.

1	.31-09	55 KM.
2	.10-22	55 KM.
3	.17-21	55 KM.
6	.19-08	55 KM.
7	.11-02	55 KM.
8	.12-05	55 KM.
9	.17-04	55 KM.
11	.27-02	55 KM.
12	.10-04	55 KM.
13	.33-06	55 KM.
14	.34-08	55 KM.
15	.17-02	55 KM.
16	.27-02	55 KM.
17	.62-04	55 KM.
19	.15-04	55 KM.
20	.34-04	55 KM.
21	.29-09	55 KM.
22	.10-22	55 KM.
23	.13-18	55 KM.
24	.39-18	55 KM.
25	.82-04	55 KM.
26	.54-04	55 KM.
31	.18-03	55 KM.
32	.40-04	55 KM.
33	.40-06	55 KM.

SYMB	SUM1	SUM2	SUM3	SUM4	SUM5	TOTAL
O_2	.0000	.1630-29	.0000	.2168-09	.0000	.2168-09
O_3	.8752-06	.8130-04	.1314-03	.7266-03	.1915-05	.9421-03
N_2	.0000	.0000	.0000	.0000	.0000	.0000
NO_2	.5040-06	.1611-04	.2663-02	.0000	.0000	.2680-02
HNO_2	.1827-03	.0000	.0000	.0000	.0000	.1827-03
N_2O_5	.1652-06	.9914-04	.0000	.0000	.0000	.9930-04
H_2O_2	.1671-05	.2829-04	.0000	.0000	.0000	.2996-04
HCHO	.8124-04	.0000	.0000	.0000	.0000	.8124-04
HNO_3	.2591-04	.7122-05	.1598-05	.0000	.0000	.3463-04
N_2O	.2364-26	.2841-06	.0000	.0000	.0000	.2841-06
HO_2	.1165-04	.0000	.0000	.0000	.0000	.1165-04
NO	.6863-27	.8522-06	.0000	.0000	.0000	.8522-06
H_2O	.9809-08	.0000	.0000	.0000	.0000	.9809-08
CH_4	.0000	.1267-26	.3800-26	.0000	.0000	.5066-26
CO_2	.0000	.2032-09	.0000	.0000	.0000	.2032-09
HCHO	.5225-04	.0000	.0000	.0000	.0000	.5225-04

ALTITUDE = 50 KM.

1	.22-09	50 KM.
2	.10-22	50 KM.
3	.16-29	50 KM.
6	.19-08	50 KM.
7	.73-03	50 KM.
8	.81-06	50 KM.
9	.66-05	50 KM.
11	.27-02	50 KM.
12	.81-05	50 KM.
13	.28-06	50 KM.
14	.28-08	50 KM.
15	.17-02	50 KM.
16	.27-02	50 KM.
17	.50-04	50 KM.
19	.12-04	50 KM.
20	.28-04	50 KM.
21	.20-09	50 KM.
22	.10-22	50 KM.
23	.13-26	50 KM.
24	.38-26	50 KM.
25	.81-04	50 KM.
26	.52-04	50 KM.
31	.18-03	50 KM.
32	.35-04	50 KM.
33	.35-06	50 KM.

SYMB	SUM1	SUM2	SUM3	SUM4	SUM5	TOTAL
O2	.0000	.0000	.0000	.1664-09	.0000	.1664-09
O3	.7495-06	.7181-04	.9775-04	.6462-03	.1907-05	.8184-03
N2	.0000	.0000	.0000	.0000	.0000	.0000
NO2	.3110-06	.1473-04	.2658-02	.0000	.0000	.2673-02
HNO2	.1826-03	.0000	.0000	.0000	.0000	.1826-03
N2O5	.1542-06	.9224-04	.0000	.0000	.0000	.9240-04
H2O2	.1473-05	.2674-04	.0000	.0000	.0000	.2821-04
HCHO	.8099-04	.0000	.0000	.0000	.0000	.8099-04
HNO3	.2305-04	.6542-05	.1570-05	.0000	.0000	.3116-04
N2O	.0000	.2435-06	.0000	.0000	.0000	.2435-06
HO2	.1059-04	.0000	.0000	.0000	.0000	.1059-04
NO	.0000	.7787-06	.0000	.0000	.0000	.7787-06
H2O	.5725-08	.0000	.0000	.0000	.0000	.5725-08
CH4	.0000	.0000	.0000	.0000	.0000	.0000
CO2	.0000	.1383-09	.0000	.0000	.0000	.1383-09
HCHO	.5182-04	.0000	.0000	.0000	.0000	.5182-04

ALTITUDE = 45 KM.

1	.17-09	45 KM.
2	.10-22	45 KM.
3	.10-22	45 KM.
6	.19-08	45 KM.
7	.65-03	45 KM.
8	.72-06	45 KM.
9	.49-05	45 KM.
11	.27-02	45 KM.
12	.74-05	45 KM.
13	.24-06	45 KM.
14	.24-08	45 KM.
15	.17-02	45 KM.
16	.27-02	45 KM.
17	.46-04	45 KM.
19	.11-04	45 KM.
20	.27-04	45 KM.
21	.14-09	45 KM.
22	.10-22	45 KM.
23	.10-22	45 KM.
24	.10-22	45 KM.
25	.81-04	45 KM.
26	.52-04	45 KM.
31	.18-03	45 KM.
32	.31-04	45 KM.
33	.31-06	45 KM.

SYMB	SUM1	SUM2	SUM3	SUM4	SUM5	TOTAL
O_2	.0000	.0000	.0000	.1103-09	.0000	.1103-09
O_3	.5635-06	.4440-04	.2643-04	.4199-03	.1887-05	.4932-03
N_2	.0000	.0000	.0000	.0000	.0000	.0000
NO_2	.1445-06	.1096-04	.2645-02	.0000	.0000	.2657-02
HNO_2	.1823-03	.0000	.0000	.0000	.0000	.1823-03
N_2O_5	.1303-06	.7297-04	.0000	.0000	.0000	.7310-04
H_2O_2	.1134-05	.2253-04	.0000	.0000	.0000	.2366-04
HCHO	.8019-04	.0000	.0000	.0000	.0000	.8019-04
HNO_3	.1836-04	.4884-05	.1461-05	.0000	.0000	.2470-04
N_2O	.0000	.1844-06	.0000	.0000	.0000	.1844-06
HO_2	.7886-05	.0000	.0000	.0000	.0000	.7886-05
NO	.0000	.5989-06	.0000	.0000	.0000	.5989-06
H_2O	.2750-08	.0000	.0000	.0000	.0000	.2750-08
CH_4	.0000	.0000	.0000	.0000	.0000	.0000
CO_2	.0000	.7511-10	.0000	.0000	.0000	.7511-10
HCHO	.5022-04	.0000	.0000	.0000	.0000	.5022-04

ALTITUDE = 40 KM.

1	.11-09	40 KM.
2	.10-22	40 KM.
3	.10-22	40 KM.
6	.19-08	40 KM.
7	.42-03	40 KM.
8	.44-06	40 KM.
9	.13-05	40 KM.
11	.26-02	40 KM.
12	.55-05	40 KM.
13	.18-06	40 KM.
14	.18-08	40 KM.
15	.17-02	40 KM.
16	.27-02	40 KM.
17	.36-04	40 KM.
19	.79-05	40 KM.
20	.23-04	40 KM.
21	.75-10	40 KM.
22	.10-22	40 KM.
23	.10-22	40 KM.
24	.10-22	40 KM.
25	.80-04	40 KM.
26	.50-04	40 KM.
31	.18-03	40 KM.
32	.25-04	40 KM.
33	.25-06	40 KM.

SYMB	SUM1	SUM2	SUM3	SUM4	SUM5	TOTAL
O2	.0000	.0000	.0000	.4605-10	.0000	.4605-10
O3	.3014-06	.9083-05	.8908-07	.1481-03	.1809-05	.1594-03
N2	.0000	.0000	.0000	.0000	.0000	.0000
NO2	.3803-07	.4244-05	.2614-02	.0000	.0000	.2618-02
HNO2	.1817-03	.0000	.0000	.0000	.0000	.1817-03
N2O5	.8090-07	.3975-04	.0000	.0000	.0000	.3983-04
H2O2	.6160-06	.1593-04	.0000	.0000	.0000	.1655-04
HCHO	.7729-04	.0000	.0000	.0000	.0000	.7729-04
HNO3	.1045-04	.2034-05	.1082-05	.0000	.0000	.1357-04
N2O	.0000	.9817-07	.0000	.0000	.0000	.9817-07
HO2	.3342-05	.0000	.0000	.0000	.0000	.3342-05
NO	.0000	.2644-06	.0000	.0000	.0000	.2644-06
H2O	.9305-09	.0000	.0000	.0000	.0000	.9305-09
CH4	.0000	.0000	.0000	.0000	.0000	.0000
CO2	.0000	.2623-10	.0000	.0000	.0000	.2623-10
HCHO	.4448-04	.0000	.0000	.0000	.0000	.4448-04

ALTITUDE = 35 KM.

1	.46-10	35 KM.
2	.10-22	35 KM.
3	.10-22	35 KM.
6	.18-08	35 KM.
7	.15-03	35 KM.
8	.91-07	35 KM.
9	.45-08	35 KM.
11	.26-02	35 KM.
12	.21-05	35 KM.
13	.97-07	35 KM.
14	.98-09	35 KM.
15	.17-02	35 KM.
16	.27-02	35 KM.
17	.20-04	35 KM.
19	.33-05	35 KM.
20	.16-04	35 KM.
21	.26-10	35 KM.
22	.10-22	35 KM.
23	.10-22	35 KM.
24	.10-22	35 KM.
25	.77-04	35 KM.
26	.44-04	35 KM.
31	.18-03	35 KM.
32	.14-04	35 KM.
33	.14-06	35 KM.

SYMB	SUM1	SUM2	SUM3	SUM4	SUM5	TOTAL
O^2	.0000	.0000	.0000	.1142-10	.0000	.1142-10
O^3	.8604-07	.1070-05	.6027-12	.4403-04	.1636-05	.4682-04
N^2	.0000	.0000	.0000	.0000	.0000	.0000
NO^2	.3668-08	.8360-06	.2573-02	.0000	.0000	.2574-02
HNO^2	.1806-03	.0000	.0000	.0000	.0000	.1806-03
$N2O^5$	.2747-07	.1894-04	.0000	.0000	.0000	.1897-04
$H2O^2$	.1802-06	.1201-04	.0000	.0000	.0000	.1219-04
HCHO	.7247-04	.0000	.0000	.0000	.0000	.7247-04
HNO^3	.3119-05	.4276-06	.6221-06	.0000	.0000	.4169-05
N2O	.0000	.2780-07	.0000	.0000	.0000	.2780-07
HO^2	.7795-06	.0000	.0000	.0000	.0000	.7795-06
NO	.0000	.5798-07	.0000	.0000	.0000	.5798-07
H2O	.1588-09	.0000	.0000	.0000	.0000	.1588-09
CH^4	.0000	.0000	.0000	.0000	.0000	.0000
CO^2	.0000	.4213-11	.0000	.0000	.0000	.4213-11
HCHO	.3648-04	.0000	.0000	.0000	.0000	.3648-04

ALTITUDE = 30 KM.

1	.11-10	30 KM.
2	.10-22	30 KM.
3	.10-22	30 KM.
6	.16-08	30 KM.
7	.44-04	30 KM.
8	.11-07	30 KM.
9	.30-13	30 KM.
11	.26-02	30 KM.
12	.42-06	30 KM.
13	.28-07	30 KM.
14	.28-09	30 KM.
15	.17-02	30 KM.
16	.27-02	30 KM.
17	.95-05	30 KM.
19	.78-06	30 KM.
20	.12-04	30 KM.
21	.42-11	30 KM.
22	.10-22	30 KM.
23	.10-22	30 KM.
24	.10-22	30 KM.
25	.72-04	30 KM.
26	.36-04	30 KM.
31	.18-03	30 KM.
32	.42-05	30 KM.
33	.42-07	30 KM.

SYMB	SUM1	SUM2	SUM3	SUM4	SUM5	TOTAL
O_2	.0000	.0000	.0000	.1043-11	.0000	.1043-11
O_3	.8226-08	.6452-07	.9845-21	.1210-04	.1368-05	.1354-04
N_2	.0000	.0000	.0000	.0000	.0000	.0000
NO_2	.3853-10	.6484-07	.2530-02	.0000	.0000	.2530-02
HNO_2	.1789-03	.0000	.0000	.0000	.0000	.1789-03
N_2O_5	.3100-08	.1182-04	.0000	.0000	.0000	.1183-04
H_2O_2	.1821-07	.1019-04	.0000	.0000	.0000	.1021-04
$HCHO$	.6723-04	.0000	.0000	.0000	.0000	.6723-04
HNO_3	.3067-06	.3462-07	.3415-06	.0000	.0000	.6828-06
N_2O	.0000	.2972-08	.0000	.0000	.0000	.2972-08
HO_2	.6936-07	.0000	.0000	.0000	.0000	.6936-07
NO	.0000	.4084-08	.0000	.0000	.0000	.4084-08
H_2O	.7439-11	.0000	.0000	.0000	.0000	.7439-11
CH_4	.0000	.0000	.0000	.0000	.0000	.0000
CO_2	.0000	.1554-12	.0000	.0000	.0000	.1554-12
$HCHO$	.2988-04	.0000	.0000	.0000	.0000	.2988-04

ALTITUDE = 25 KM.

1	.10-11	25 KM.
2	.10-22	25 KM.
3	.10-22	25 KM.
6	.14-08	25 KM.
7	.12-04	25 KM.
8	.65-09	25 KM.
9	.49-22	25 KM.
11	.25-02	25 KM.
12	.32-07	25 KM.
13	.29-08	25 KM.
14	.30-10	25 KM.
15	.17-02	25 KM.
16	.27-02	25 KM.
17	.59-05	25 KM.
19	.69-07	25 KM.
20	.10-04	25 KM.
21	.16-12	25 KM.
22	.10-22	25 KM.
23	.10-22	25 KM.
24	.10-22	25 KM.
25	.67-04	25 KM.
26	.30-04	25 KM.
31	.18-03	25 KM.
32	.68-06	25 KM.
33	.68-08	25 KM.

SYMB	SUM1	SUM2	SUM3	SUM4	SUM5	TOTAL
O_2	.0000	.0000	.0000	.1283-13	.0000	.1283-13
O_3	.1103-09	.6297-09	.0000	.2901-05	.1004-05	.3906-05
N_2	.0000	.0000	.0000	.0000	.0000	.0000
NO_2	.8713-14	.7299-09	.2481-02	.0000	.0000	.2481-02
HNO_2	.1764-03	.0000	.0000	.0000	.0000	.1764-03
N_2O_5	.4161-10	.9368-05	.0000	.0000	.0000	.9368-05
H_2O_2	.2702-09	.9027-05	.0000	.0000	.0000	.9027-05
HCHO	.6154-04	.0000	.0000	.0000	.0000	.6154-04
HNO_3	.4140-08	.4259-09	.1838-06	.0000	.0000	.1884-06
N_2O	.0000	.2407-09	.0000	.0000	.0000	.2407-09
HO_2	.8631-09	.0000	.0000	.0000	.0000	.8631-09
NO	.0000	.3702-10	.0000	.0000	.0000	.3702-10
H_2O	.4989-13	.0000	.0000	.0000	.0000	.4989-13
CH_4	.0000	.0000	.0000	.0000	.0000	.0000
CO_2	.0000	.5987-15	.0000	.0000	.0000	.5987-15
HCHO	.2438-04	.0000	.0000	.0000	.0000	.2438-04

ALTITUDE = 20 KM.

1	.13-13	20 KM.
2	.10-22	20 KM.
3	.10-22	20 KM.
6	.10-08	20 KM.
7	.29-05	20 KM.
8	.63-11	20 KM.
9	.10-22	20 KM.
11	.25-02	20 KM.
12	.36-09	20 KM.
13	.24-09	20 KM.
14	.24-11	20 KM.
15	.17-02	20 KM.
16	.27-02	20 KM.
17	.47-05	20 KM.
19	.86-09	20 KM.
20	.90-05	20 KM.
21	.60-15	20 KM.
22	.10-22	20 KM.
23	.10-22	20 KM.
24	.10-22	20 KM.
25	.62-04	20 KM.
26	.24-04	20 KM.
31	.18-03	20 KM.
32	.19-06	20 KM.
33	.19-08	20 KM.

SYMB	SUM1	SUM2	SUM3	SUM4	SUM5	TOTAL
O_2	.0000	.0000	.0000	.6338-17	.0000	.6338-17
O_3	.5440-13	.3874-12	.0000	.7953-06	.6677-06	.1463-05
N_2	.0000	.0000	.0000	.0000	.0000	.0000
NO_2	.9714-21	.4089-12	.2435-02	.0000	.0000	.2435-02
HNO_2	.1738-03	.0000	.0000	.0000	.0000	.1738-03
N_2O_5	.1455-13	.7974-05	.0000	.0000	.0000	.7974-05
H_2O_2	.1546-12	.8180-05	.0000	.0000	.0000	.8180-05
HCHO	.5651-04	.0000	.0000	.0000	.0000	.5651-04
HNO_3	.2072-11	.2974-12	.1042-06	.0000	.0000	.1042-06
N_2O	.0000	.9571-10	.0000	.0000	.0000	.9571-10
HO_2	.4675-12	.0000	.0000	.0000	.0000	.4675-12
NO	.0000	.1689-13	.0000	.0000	.0000	.1689-13
H_2O	.1411-16	.0000	.0000	.0000	.0000	.1411-16
CH_4	.0000	.0000	.0000	.0000	.0000	.0000
CO_2	.0000	.1007-18	.0000	.0000	.0000	.1007-18
HCHO	.2038-04	.0000	.0000	.0000	.0000	.2038-04

ALTITUDE = 15 KM.

1	.63-17	15 KM.
2	.10-22	15 KM.
3	.10-22	15 KM.
6	.67-09	15 KM.
7	.80-06	15 KM.
8	.39-14	15 KM.
9	.10-22	15 KM.
11	.24-02	15 KM.
12	.20-12	15 KM.
13	.95-10	15 KM.
14	.96-12	15 KM.
15	.17-02	15 KM.
16	.27-02	15 KM.
17	.40-05	15 KM.
19	.47-12	15 KM.
20	.82-05	15 KM.
21	.10-18	15 KM.
22	.10-22	15 KM.
23	.10-22	15 KM.
24	.10-22	15 KM.
25	.57-04	15 KM.
26	.20-04	15 KM.
31	.17-03	15 KM.
32	.10-06	15 KM.
33	.10-08	15 KM.

SYMB	SUM1	SUM2	SUM3	SUM4	SUM5	TOTAL
O_2	.0000	.0000	.0000	.4932-21	.0000	.4932-21
O_3	.1311-18	.1124-15	.0000	.3622-06	.4971-06	.8593-06
N_2	.0000	.0000	.0000	.0000	.0000	.0000
NO_2	.7653-34	.7568-16	.2408-02	.0000	.0000	.2408-02
HNO_2	.1722-03	.0000	.0000	.0000	.0000	.1722-03
N_2O_5	.1505-19	.7318-05	.0000	.0000	.0000	.7318-05
H_2O_2	.4626-18	.7750-05	.0000	.0000	.0000	.7750-05
HCHO	.5371-04	.0000	.0000	.0000	.0000	.5371-04
HNO_3	.5580-17	.7096-16	.7412-07	.0000	.0000	.7412-07
N_2O	.0000	.5708-10	.0000	.0000	.0000	.5708-10
HO_2	.5541-16	.0000	.0000	.0000	.0000	.5541-16
NO	.0000	.5266-17	.0000	.0000	.0000	.5266-17
H_2O	.1944-22	.0000	.0000	.0000	.0000	.1944-22
CH_4	.0000	.0000	.0000	.0000	.0000	.0000
CO_2	.0000	.9539-25	.0000	.0000	.0000	.9539-25
HCHO	.1842-04	.0000	.0000	.0000	.0000	.1842-04

ALTITUDE = 10 KM.

1	.49-21	10 KM.
2	.10-22	10 KM.
3	.10-22	10 KM.
6	.50-09	10 KM.
7	.36-06	10 KM.
8	.11-17	10 KM.
9	.10-22	10 KM.
11	.24-02	10 KM.
12	.38-16	10 KM.
13	.57-10	10 KM.
14	.57-12	10 KM.
15	.17-02	10 KM.
16	.27-02	10 KM.
17	.37-05	10 KM.
19	.55-16	10 KM.
20	.77-05	10 KM.
21	.95-25	10 KM.
22	.10-22	10 KM.
23	.10-22	10 KM.
24	.10-22	10 KM.
25	.54-04	10 KM.
26	.18-04	10 KM.
31	.17-03	10 KM.
32	.74-07	10 KM.
33	.74-09	10 KM.

END OF COMPUTATION.

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APPENDIX A: AUXILIARY PROGRAMS AND FILES

Several auxiliary programs are required for data preparation and manipulation and for the plotting of input and output data. For the conveniences of the user, documentation and data set-up have been provided on comment cards at the beginning of each program's main routine.

Backup decks, program listings with samples of the output (including plots) also have been provided. These programs are briefly identified below.

There are also numerous tape files containing absorption data as well as three current direct access files. A list identifying these tapes and files has been prepared for the user.

ABSPLT — Produces large-scale multiple plots for the absorption coefficients.

DA* — This file is made up of three FORTRAN elements, OPFILE, UPDATE, and PRNT. Each of these become independent data-handling programs when mapped into absolute elements with the subroutine DACESS. Program OPFILE opens a 270 track (may be changed) FASTRAND file for the absorption coefficients (cm^{-1}). This size file will contain about 36 x 8500 zeros. UPDATE allows absorption coefficients to be read from magnetic tape or FASTRAND files into the desired location in the opened direct access file. PRNT will print out all, or any desired portion, of this file.

DEN — Small routine to select and format ASA density data for the JVALUE program.

JONE3 — Program to average absorption data over 1 A intervals. Generally, a two-point interpolation is used for structured data and a four-point interpolation for smooth data. It is necessary to check the integrity of the maxima and minima for any except linear interpolation since these may be offset. ABSPLT allows plotting of the generated and original data on one grid. This program has an internal plot routine (subroutines QA and QB); however, the since-acquired COMPLOT software is superior for purposes of comparison.

JVALU5 — Uses pre-calculated solar flux values to calculate photodissociation rates for species not included in ASA such as those important to the Freon problem.

DENPLT/ DNPLT — Generates density profiles from ASA output or from JVALUE data.

FLUX	Program which converts solar flux intensities from units of watts $m^{-2}nm^{-2}$ to the average number of photons-cm^{-2}-$\mathring{A}^{-1}$-sec^{-1}.
FMT	Blocks multiple sets of photodissociation rates for comparison.
JAYPLT/ JYPLT2	Plotter for the individual photodissociation rates and for multiple plotting of photodissociation rates for purposes of comparison.
LEEPLT	Individual plots of absorption coefficients with variable grid size used to compare generated data with original values.
MEAN	Uses multiple FASTRAND files of photodissociation rates to calculate mean rates.
RADPLT	Program to generate large scale plots (500 $\mathring{A}$ intervals) of the solar flux output from JVALUE.
SOLPLT	Special purpose, small scale plotting routine for the altitude dependent solar flux generated by JVALUE. Experimental data points may be plotted with the line plot in version 4.
ZENITH	JVALUE subroutine, modified upon request to run as an independent program, which allows the calculation of up to 50 zenith angles at a time.

*I wish to express my appreciation to Walter Decker, formerly stationed at White Sands Missile Range, for developing these programs.

I also wish to express my gratitude to Mr. Robert Lee, who recently retired from ASL, for his extensive help in programming over the past several years.

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